

AERONAUTICAL AND ASTRONAUTICAL ENGINEER

ANGULAR RATE ESTIMATION FOR MULTI-BODY SPACECRAFT ATTITUDE CONTROL

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Spacecraft with high performance attitude control systems requirements have traditionally relied on imperfect mechanical gyroscopes for primary attitude determination. Gyro bias errors are connected with a Kalman filter algorithm that uses updates from precise attitude sensors like star trackers. Gyroscopes, however, have a tendency to degrade or fail on orbit, becoming a life-limiting factor for many satellites. When errors become erratic, pointing accuracy may be lost during short star gaps. Unpredictable gyros degradations have impacted NASA spacecraft missions such as Skylab and Hubble Space Telescope as several DoD and ESA satellites. An alternative source of angular rate information is a software implemented real time dynamic model. Inputs to the model from internal sensors and known spacecraft parameters enable the tracking of total system angular momentum from which body rates can be determined. With this technique, the Kalman filter algorithm provides error corrections to the dynamic model. The accuracy of internal sensor and input parameters determine the effectiveness of this angular rate estimation technique. This thesis presents the background for understanding and implementation of the technique into a representative attitude determination system. The system is incorporated into an attitude simulation model developed in SIMULINK to evaluate the effects of dynamic modeling errors and sensor inaccuracies. Results are presented that indicate that real time dynamic modeling is an effective method of angular rate determination for maneuvering multi-body spacecraft attitude control systems.

DoD KEY TECHNOLOGY AREAS: Space Vehicles, Modeling and Simulation

KEYWORDS: Dynamic Gyro, Kalman Filter, Attitude Determination, Rate Estimation, Star Trackers, Attitude Simulation, Multi-body Dynamics, Quaternion, MATLAB, SIMULINK

ELECTRICAL ENGINEER

AN IMPROVED MAGNETIC, ANGLE RATE, GRAVITY (MARG) BODY TRACKING SYSTEM

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This thesis proposes the design of an improved Magnetic, Angular Rate, Gravity (MARG) Body Tracking System. The current MARG Body Tracking System is limited to tracking three limb-segments. The MARG sensors are physically connected to a desktop computer by cables.

In this thesis, a multiplexing circuit was implemented to allow tracking of 15 limb-segments. Processing was moved from a desktop computer to a wearable computer and wireless communication was implemented using an IEEE 802.11b spread spectrum wireless LAN. The resultant system is able to track the entire human body and is untethered. The range of the system is the same as that of the wireless LAN which can be extended with the use of repeaters. This thesis work will ultimately allow human insertion into virtual environments for training and other applications.

DoD KEY TECHNOLOGY AREA: Computing and Software, Human System Interface, Sensors

KEYWORDS: Human Body Tracking